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(54) **Textile surgical implants**

Chirurgische Textilimplantate

Implants chirurgicaux en textile

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(73) Proprietor: **ELLIS DEVELOPMENTS LIMITED**  
**Nottingham NG3 2AP (GB)**

(72) Inventor: **Ellis, Julian Garth**  
**Southwell, Notts, NG25 0UJ (GB)**

(74) Representative: **Goodwin, Mark et al**  
**Wilson, Gunn, M'Caw,**  
**41-51 Royal Exchange,**  
**Cross Street**  
**Manchester M2 7BD (GB)**

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**EP 0 744 162 B1**

## Description

[0001] This invention relates to a textile surgical implant.

[0002] The manufacture of textile surgical implants often requires the manufacture of a low number of items. Modern textile manufacturing methods, however, are usually only cost effective if large numbers are produced. An advantage of high volume automatic manufacturing methods is that the articles manufactured are almost exactly alike. Such similarity is required by the needs of modern scientific surgery, in order that all patients shall be treated alike and that there is no untoward variation from implant to implant.

[0003] It is, therefore, desirable that textile implants should be able to be made cost effectively in small numbers on machinery that is mechanically or electronically controlled in such a way that each item produced to the same design will be virtually identical.

[0004] It is also desirable that the design method used shall be simple and quick to carry out, in order to minimise design costs. Low design costs also facilitate the cost-effective production of bespoke implants, which may be desirable for unusual medical conditions or for use in patients where it is necessary to produce an implant of an exact size to fit that person.

[0005] Ideally a textile implant will have the textile fibres placed in a position and direction which accord with the design requirements in order that they may carry out their function correctly, whether it be load-bearing or otherwise.

[0006] The present invention is intended to deal with the above-mentioned problems.

[0007] The document WO 9317635 A discloses a composite prosthesis including a textile implant comprising an array of fibres, and an adhesion barrier. The implant and the barrier are joined by an adhesive, sewing or moulding.

[0008] According to the present invention there is provided a textile surgical implant in combination with a base cloth, said implant comprising an array of fibres, characterised in that the implant is formed by placing the fibres forming the implant in position on said base cloth by embroidery.

[0009] The term implant as used herein is not confined solely to implants that are intended to be surgically or otherwise implanted in the body, but also includes stents and the like such as are implanted in the oesophagus.

[0010] Embroidery is normally defined as work with a needle and thread upon cloth. In conventional embroidery the fibres are placed with a needle according to the requirements of the aesthetic design selected. In the manufacture of a textile surgical implant, the fibres can be placed according to the functional requirements of the design, for example so that one or more yarns in the structure may efficiently carry a load in an artificial ligament.

[0011] Many modern embroidery machines comprise a sewing head above an X-Y plotter. The plotter can be moved with great precision below the needle head (or vice-versa) so that the sewing head moves relative to the base cloth as required. The movements are controlled by punched card, or preferably, electronic computer control. An alternative arrangement is for the sewing head to move, whilst the base cloth remains stationary.

[0012] Preferably the implant is of substantially triangular shape.

[0013] The definition of embroidery implies that the embroidery stitches must be made upon a base cloth. However, according to one embodiment of the present invention there is provided a base cloth that is soluble, so that after the implant is formed upon the base cloth, the cloth can be dissolved away and only the embroidered stitched structure remains. Using design rules known to those skilled in the art, embroidered structures can be made so that placed fibres of the embroidery retain their structural integrity and hold together after the base cloth has been dissolved away. The dissolution can be by aqueous medium if a water soluble base fabric is used such as a base fabric made from polyvinyl acetate, or alginate. Alternatively a solvent such as acetone may be used for example when an acetate base fabric is utilised. Other base fabrics can be used which may be removed for example with acid, alkali, or organic solvent or with water, or by heat or other method.

[0014] In one embodiment of the invention a sheet material, such as polyglycolic acid, is used which degrades or is absorbed after implantation, leaving more permanent parts of the embroidered structure within the body. The implant or the base fabric can be impregnated with one or more growth factors, or angiogenic or neurogenic materials that may stimulate the production of blood vessels, nerves, or other types of tissue around and/or into the implant.

[0015] Specific embodiments of the invention will now be described with reference to the accompanying drawings in which:-

Fig.1 is a plan view of a mesh structure;

Fig.2 is a plan view of another mesh structure suitable for repair of a tendon or ligament;

Fig.3 illustrates a tubular stent suitable for insertion into hollow viscera; and

Fig.4 shows a material which can be used, inter alia, for the stent of Fig.3.

[0016] Referring first to Fig.1 a mesh structure comprises crossing threads which are laid substantially at right angles to each other. The interlocking may be achieved by a number of interlocking methods well known to those skilled in the art. Generally the interlocking is effected when the first laid down layer is crossed

by the second laid part, when threads from the under-thread and needle thread pass under and over the first laid thread and are interlocked by lockthread stitching as usually used for the embroidery. Different ways of interlock will give different load extension characteristics to the implant for different applications or different patients.

**[0017]** Such a mesh can be used to act as a reinforcing patch within the body. For example a patient may suffer from an incisional hernia where some of the internal tissues of the gut may protrude through the walls of the abdomen and the internal tissues are only held within the body by a thin layer of the body wall. The edges of the hernia may have weakened as a result of the hernia or from some other cause, which makes repair using conventional sutures difficult. The provision of a patch will assist the surgeon to obtain a good repair by enabling him to stitch the tissue at a site remote from the weak edges. The patch can also provide a scaffold on which a new tissue may grow. The requirements of any patch include that it shall have a high bursting strength, that it shall be easy to cut to size appropriate to the condition of the patient without fraying or unravelling from the cut edges. Many woven structures have good properties with regard to bursting strength, but will fray readily from a cut edge. The use of a hot knife to cut thermoplastic fibres to prevent them fraying is undesirable because of the inconvenience of carrying out this in operating theatre conditions and the sharp edges (and possibly toxic degradation products) that thermal cutting often leaves.

**[0018]** The provision of a thermoplastic monofilament patch where intersecting fibres in a mesh are thermally bonded is known, but any cut edges of the monofilament comprising the patch may be undesirably sharp and thermal bonding restricts the choice of fibres to those which are thermoplastic. The use of adhesives to bond the intersections of the mesh is inconvenient and may introduce a biologically incompatible component to the implant. According to the present invention any implantable fibre may be used, since the intersections of the mesh are stitched and are resistant to fraying when the mesh is cut.

**[0019]** The invention provides a patch for the repair of tendon or ligament. For example the rotator cuff of the shoulder is difficult to repair without the use of textile reinforcement. Frequently a multiplicity of suture threads is used, but sometimes this method of reinforcement is insufficient and a reinforcing textile fabric is required. The use of a hood as described in PCT International Patent Appln.No.WO 91/03993 is one example. This provides a woven or knitted flexible fabric. The openness of the mesh is chosen so as to allow tissue ingrowth without being so open that the structural integrity is lost. The present invention includes the provision of an embroidered mesh, with areas of extra strength to carry localised heavier loads. One embodiment of this aspect of the invention is shown in Fig.2. The mesh is ideally provided so that the holes are spaced approxi-

mately 2 mm apart and are approximately 1 mm square. The strength of the mesh is such that it must carry a minimum load of approximately body weight. The use of embroidery to form the mesh 1, has the advantage that the mesh can be locally reinforced using a different type of thread or higher concentration or density of threads or using a multiplicity of the same thread as illustrated by the bold lines referenced 2. In a preferred embodiment the main mesh 1 is made using a braided polyester fibre 0.35 mm in diameter and the reinforcement 2 is a polyester braid of 1.5 mm diameter.

**[0020]** The invention also provides an implant to form a sheet material having a different stiffness in one axis to the stiffness in the other axis. An implant of this kind, known as a stent, an example of which is disclosed in UK Patent Appln.No.GB 2270264 is in the form of a tube that can be compressed for insertion into the human or animal body to relieve blocking of the oesophagus or other hollow viscera by tumours or other disorders. If the coiled stent is made from stiff anisotropic sheet material and wound up tightly to reduce its diameter in order to insert it within the oesophagus, the tube becomes so rigid that the stent becomes difficult to insert in some patients, for example elderly patients with stiff necks or protuberant teeth. Fig.3 shows a self expanding solid walled tube similar to a coiled spring tube. The tube can be wound tightly to form a low diameter tube, or stent, which may be inserted into hollow viscera within the body and then allowed to expand, pushing aside any blockage of the hollow viscus that may have been caused by a tumour or other disorder. One example of an application is to patients in whom the oesophagus may have become blocked by a malignant tumour, making swallowing difficult.

**[0021]** In the embodiment of Fig.3 the material forming the stent is made by laying stiff fibres in one axis direction of the stent onto a base embroidery material and the other direction with less stiff or no fibres. This results in an anisotropic material that when wound tightly about an axis parallel to the said other direction into a low diameter tube for insertion within the hollow viscus is much less stiff in the length axis, yet retains its springiness in the radial direction. In the embodiment shown in Fig.3 the stent is formed by winding a strip of fabric about an axis such that each turn other than the first slightly overlaps the preceding turn, thus forming a tube with a substantially continuous wall surface. In use the stent diameter is reduced by tightening the turns and then positioned in its desired location, for example in a hollow viscus, the lower stiffness of the stent in the axial direction making it easy to insert in position. Once in position the stent is allowed to expand within the hollow viscus, pushing aside a tumour or other obstruction, yet it retains flexibility in the length direction.

**[0022]** In a particularly preferred embodiment, the fibres are arranged as shown in Fig.4, the longitudinal fibres 10 are monofilament polyester of high stiffness and the lateral fibres 12 are of lower stiffness monofila-

ment polyester. If this material is coiled into a stent of the kind shown in Fig.3 and heat-set into shape, the stent, when tightly coiled for insertion into the oesophagus of the patient, remains flexible in the longitudinal axis and may be more easily inserted.

[0023] It may be seen from the foregoing description and examples that the invention has a wide number of applications, not confined to those described herein.

#### Claims

1. A textile surgical implant in combination with a base cloth, said implant comprising an array of fibres, **characterised in that** the implant has been formed by placing the fibres forming the implant in position on said base cloth by embroidery.
2. A combination as claimed in Claim 1, wherein the base cloth is removable from the fibres before or after location of the implant in a patient.
3. A combination as claimed in Claim 1 or Claim 2, wherein the base cloth is soluble.
4. A combination as claimed in Claim 1 or Claim 2, wherein the base cloth is adapted to degrade and/or be absorbed after the implant is implanted in a patient.
5. A combination as claimed in any preceding claim, wherein the fibres are arranged as a mesh.
6. A combination as claimed in Claim 5, wherein the mesh is reinforced in at least a part thereof.
7. A combination as claimed in any preceding claim, wherein said implant is of substantially triangular shape.
8. A combination as claimed in any of Claims 1 to 6, having fibres which give greater stiffness in one direction than in another direction.
9. A combination as claimed in Claim 8, wherein the directions are substantially at right angles.
10. A combination as claimed in Claim 8 or Claim 9, said implant being in the form of a tube having a radial stiffness greater than the stiffness in the axial direction.
11. A combination as claimed in Claim 10, wherein the tube has been formed from a strip having fibres arranged in two directions, the strip being wound about an axis.
12. A combination as claimed in Claim 11, wherein the

strip has been wound in a plurality of turns and each turn of the strip, other than the first, overlaps the preceding turn.

13. A combination as claimed in any one of claims 10 to 12, wherein the tube is heat set to retain its shape.
14. A combination as claimed in any preceding claim and comprising one or more growth factors or angiogenic or neurogenic materials.
15. A method of making an implant in combination with a base cloth, said implant comprising an array of fibres formed on said base cloth, the method comprising placing the fibres in position on said base cloth by embroidery.
16. A method as claimed in Claim 15, wherein the base cloth is removed after the fibres have been placed in position and before the implant is implanted in a patient.
17. A method as claimed in Claim 16, wherein the base cloth is soluble and is removed by dissolving it in a solvent.
18. A method as claimed in claim 15, wherein the base cloth is adapted to degrade and/or be absorbed after the implant has been implanted in a patient.
19. A method as claimed in any of Claims 15 to 18 wherein the fibres are arranged as a mesh (1).
20. A method as claimed in Claim 19 and comprising reinforcing the mesh in at least a part (2) thereof.
21. A method as claimed in Claim 19 or Claim 20, wherein the fibres are placed in the mesh giving greater stiffness in one direction than in another direction.
22. A method as claimed in Claim 21, wherein fibres giving greater stiffness are placed at substantially right angles to fibres giving differential stiffness.
23. A method as claimed in Claim 21 or 22, wherein the array of fibres are formed into the form of a tube having a radial stiffness greater than the stiffness in the axial direction.
24. A method as claimed in Claim 23, wherein the tube is formed from a strip having fibres arranged in two directions by winding the strip about an axis.
25. A method as claimed in Claim 24, wherein the strip is wound in a plurality of turns, each turn of the strip, other than the first, overlapping the preceding turn.

26. A method as claimed in any of Claims 23 to 25, wherein the tube is heat set to retain its shape.

#### Patentansprüche

1. Chirurgisches Textilimplantat in Kombination mit einem Grundgewebe, wobei das Implantat eine Anordnung von Fasern umfaßt,  
**dadurch gekennzeichnet, daß** das Implantat dadurch hergestellt wurde, daß die das Implantat bildenden Fasern durch Sticken auf das Grundgewebe aufgebracht worden sind. 10
2. Kombination nach Anspruch 1, bei der das Grundgewebe vor oder nach dem Einsetzen des Implantats in einen Patienten von den Fasern entfernt werden kann. 15
3. Kombination nach Anspruch 1 oder Anspruch 2, bei der das Grundgewebe löslich ist. 20
4. Kombination nach Anspruch 1 oder Anspruch 2, bei der das Grundgewebe abgebaut und/oder absorbiert werden kann, nachdem das Implantat in einen Patienten implantiert worden ist. 25
5. Kombination nach einem vorhergehenden Anspruch, bei der die Fasern als Netz angeordnet sind. 30
6. Kombination nach Anspruch 5, bei der zumindest ein Teil des Netzes verstärkt ist.
7. Kombination nach einem vorhergehenden Anspruch, bei der das Implantat im wesentlichen von dreieckiger Form ist. 35
8. Kombination nach einem der Ansprüche 1 bis 6 mit Fasern, die in einer Richtung eine größere Steifigkeit als in einer anderen Richtung aufweisen. 40
9. Kombination nach Anspruch 8, bei der die Richtungen im wesentlichen rechtwinklig zueinander verlaufen. 45
10. Kombination nach Anspruch 8 oder Anspruch 9, bei der das Implantat die Form eines Schlauches hat, dessen radiale Steifigkeit größer ist als die Steifigkeit in axialer Richtung. 50
11. Kombination nach Anspruch 10, bei der der Schlauch aus einem Streifen geformt ist, dessen Fasern in zwei Richtungen angeordnet sind, wobei der Streifen um eine Achse gewickelt ist. 55

12. Kombination nach Anspruch 11, bei der der Streifen in einer Vielzahl von Windungen gewickelt ist und jede Windung des Streifens außer der ersten Windung die vorhergehende Windung überlappt.
13. Kombination nach einem der Ansprüche 10 bis 12, bei der der Schlauch zur Beibehaltung seiner Form wärmegehärtet ist.
14. Kombination nach einem vorhergehenden Anspruch, die einen oder mehrere Wachstumsfaktoren oder gefäßbildende oder neurogene Stoffe umfaßt.
15. Verfahren zur Herstellung eines Implantats in Kombination mit einem Grundgewebe, wobei das Implantat eine auf das Grundgewebe aufgebrachte Anordnung von Fasern umfaßt, wobei das Verfahren das Anbringen der Fasern an dem Grundgewebe durch Sticken umfaßt.
16. Verfahren nach Anspruch 15, bei dem das Grundgewebe entfernt wird, nachdem die Fasern angebracht worden sind und bevor das Implantat in einen Patienten implantiert wird.
17. Verfahren nach Anspruch 16, bei dem das Grundgewebe löslich ist und durch Lösen in einem Lösungsmittel entfernt wird.
18. Verfahren nach Anspruch 15, bei dem das Grundgewebe abgebaut und/oder absorbiert werden kann, nachdem das Implantat in einen Patienten implantiert worden ist.
19. Verfahren nach einem der Ansprüche 15 bis 18, bei dem die Fasern als Netz (1) angeordnet sind.
20. Verfahren nach Anspruch 19, das das Verstärken zumindest eines Teiles (2) des Netzes umfaßt.
21. Verfahren nach Anspruch 19 oder Anspruch 20, bei dem die Fasern in einem Netz angeordnet sind, das in einer Richtung eine größere Steifigkeit als in einer anderen Richtung aufweist.
22. Verfahren nach Anspruch 21, bei dem die Fasern von größerer Steifigkeit im wesentlichen rechtwinklig zu Fasern anderer Steifigkeit angeordnet sind.
23. Verfahren nach Anspruch 21 oder 22, bei dem die Anordnung von Fasern in Form eines Schlauches ausgebildet ist, dessen radiale Steifigkeit größer ist als die Steifigkeit in axialer Richtung.

24. Verfahren nach Anspruch 23, bei dem der Schlauch aus einem Streifen, dessen Fasern in zwei Richtungen angeordnet sind, dadurch geformt wird, daß der Streifen um eine Achse gewickelt wird.
25. Verfahren nach Anspruch 24, bei dem der Streifen in einer Vielzahl von Windungen gewickelt ist, wobei jede Windung des Streifens außer der ersten Windung die vorhergehende Windung überlappt.
26. Verfahren nach einem der Ansprüche 23 bis 25, bei dem der Schlauch zur Beibehaltung seiner Form wärmegehärtet ist.

### Revendications

1. Implant chirurgical textile en combinaison avec un tissu de base, ledit implant comprenant un réseau de fibres, **caractérisé en ce que** l'implant a été formé en plaçant les fibres formant l'implant en position sur ledit tissu de base par broderie.
2. Combinaison selon la revendication 1, dans laquelle le tissu de base peut être éliminé des fibres avant ou après mise en place de l'implant chez un patient.
3. Combinaison selon la revendication 1 ou 2, dans laquelle le tissu de base est soluble.
4. Combinaison selon la revendication 1 ou 2, dans laquelle le tissu de base est à même de se dégrader et/ou d'être absorbé après que l'implant a été implanté chez un patient.
5. Combinaison selon l'une quelconque des revendications précédentes, dans laquelle les fibres sont agencées en treillis.
6. Combinaison selon la revendication 5, dans laquelle le treillis est renforcé dans au moins une de ses parties.
7. Combinaison selon l'une quelconque des revendications précédentes, dans laquelle ledit implant est de forme sensiblement triangulaire.
8. Combinaison selon l'une quelconque des revendications 1 à 6, ayant des fibres qui confère une rigidité plus élevée dans une direction que dans une autre direction.
9. Combinaison selon la revendication 8, dans laquelle les directions sont sensiblement à angles droits.
10. Combinaison selon la revendication 8 ou 9, ledit im-

plant se présentant sous la forme d'un tube ayant une rigidité radiale supérieure à la rigidité dans la direction axiale.

- 5 11. Combinaison selon la revendication 10, dans laquelle le tube a été formé à partir d'une bande ayant des fibres agencées dans deux directions, la bande étant enroulée autour d'un axe.
- 10 12. Combinaison selon la revendication 11, dans laquelle la bande a été bobinée en une pluralité de spires et chaque spire de la bande, en dehors de la première, chevauche la spire précédente.
- 15 13. Combinaison selon l'une quelconque des revendications 10 à 12, dans laquelle le tube est fixé à la chaleur pour conserver sa forme.
14. Combinaison selon l'une quelconque des revendications précédentes, comprenant un ou plusieurs facteurs de croissance ou matériaux angiogéniques ou neurogéniques.
- 25 15. Procédé de fabrication d'un implant en combinaison avec un tissu de base, ledit implant comprenant un réseau de fibres formées sur ledit tissu de base, le procédé comprenant la mise en place des fibres sur ledit tissu de base par broderie.
- 30 16. Procédé selon la revendication 15, dans lequel le tissu de base est éliminé après que les fibres ont été mises en place et avant que l'implant ait été implanté chez un patient.
- 35 17. Procédé selon la revendication 16, dans lequel le tissu de base est soluble et est éliminé en le dissolvant dans un solvant.
- 40 18. Procédé selon la revendication 15, dans lequel le tissu de base est à même de se dégrader et/ou d'être absorbé après que l'implant a été implanté chez un patient.
- 45 19. Procédé selon l'une quelconque des revendications 15 à 18, dans lequel les fibres sont agencées en treillis (1).
- 50 20. Procédé selon la revendication 19, comprenant le renforcement du treillis dans au moins une de ses parties (2).
21. Procédé selon la revendication 19 ou 20, dans lequel les fibres sont placées dans le treillis pour conférer une rigidité plus élevée dans une direction que dans une autre direction.
- 55 22. Procédé selon la revendication 21, dans lequel les fibres conférant une rigidité plus élevée sont pla-

cées à angles sensiblement droits par rapport aux fibres conférant une rigidité différentielle.

- 23.** Procédé selon la revendication 21 ou 22, dans lequel le réseau de fibres se présente sous la forme d'un tube ayant une rigidité radiale supérieure à la rigidité dans la direction axiale. 5
- 24.** Procédé selon la revendication 23, dans lequel le tube se présente sous la forme d'une bande ayant des fibres agencées dans deux directions en enroulant la bande autour d'un axe. 10
- 25.** Procédé selon la revendication 24, dans lequel la bande est bobinée en une pluralité de spires, chaque spire de la bande, en dehors de la première, chevauchant la spire précédente. 15
- 26.** Procédé selon l'une quelconque des revendications 23 à 25, dans lequel le tube est fixé à la chaleur pour conserver sa forme. 20

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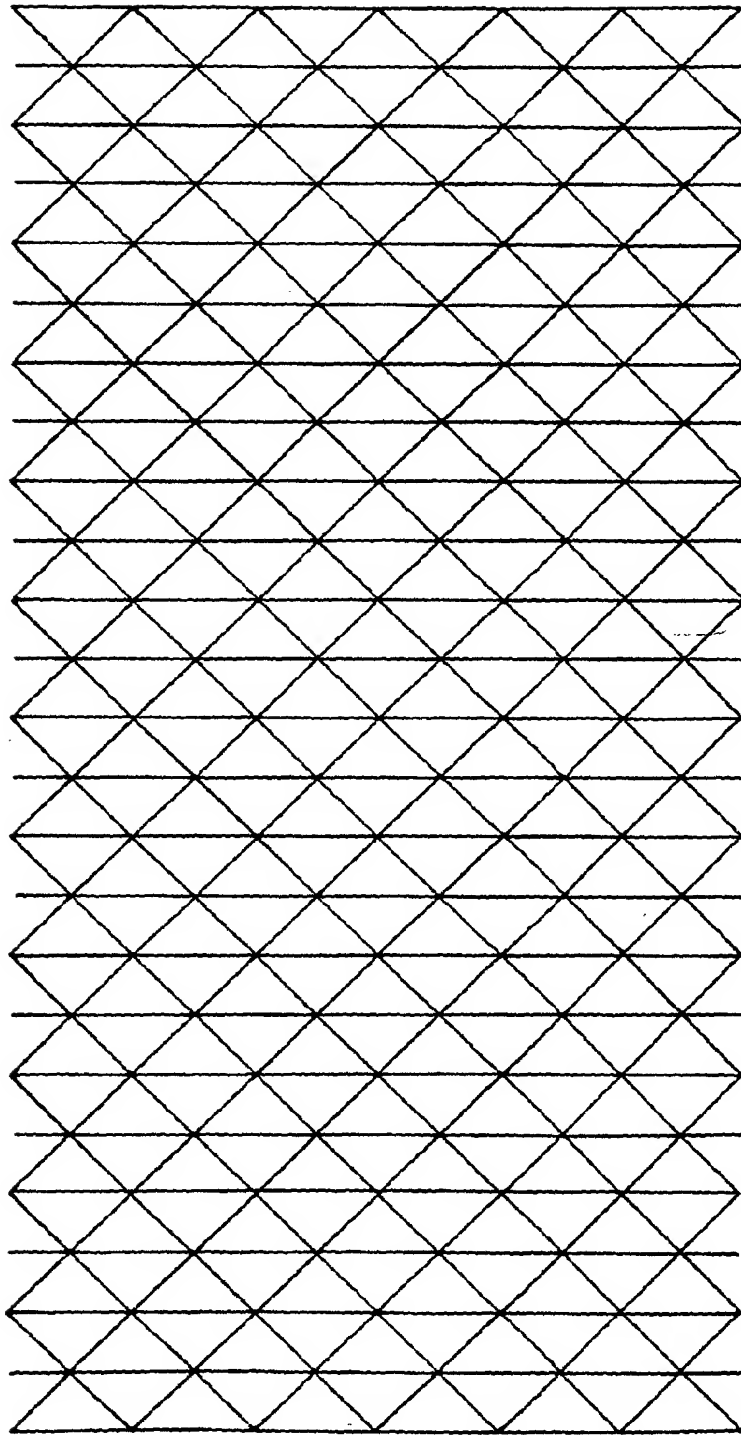
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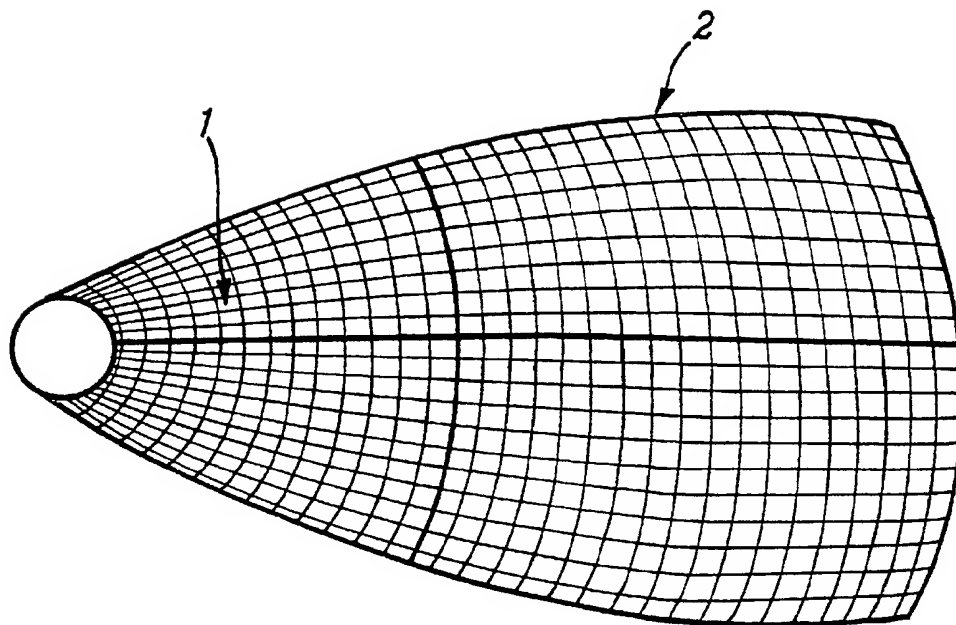
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**FIG. 1**





**FIG. 2**

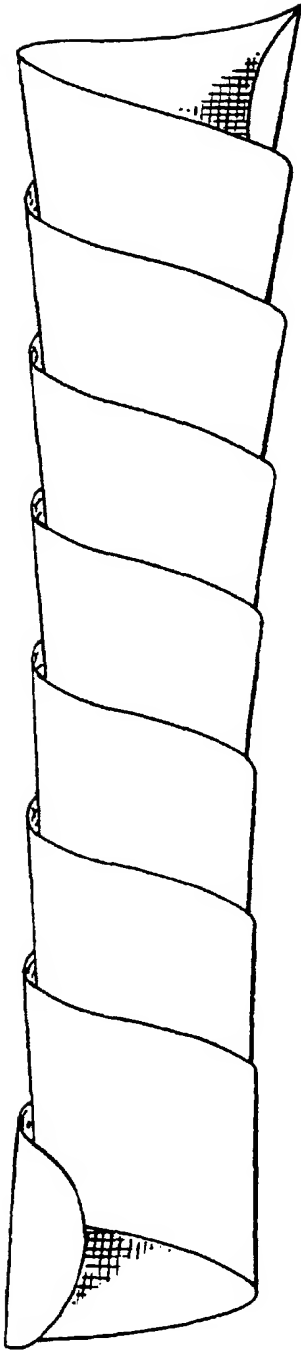


FIG. 3

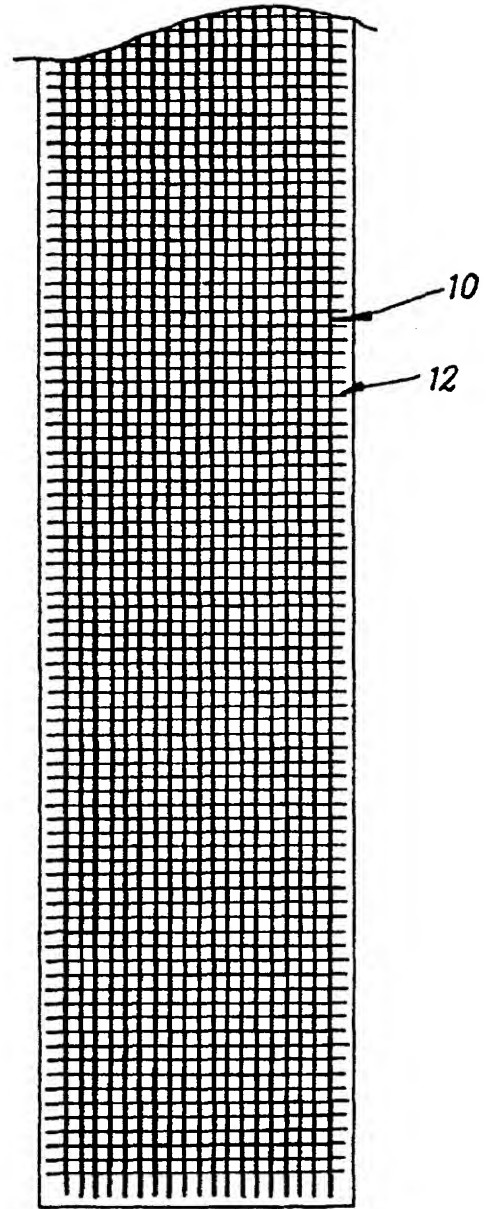


FIG. 4